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AN INVESTIGATION OF THE FACTORS AFFECTING THE GROWTH OF AQUATIC PLANTS ON THE STILLWATER WILDLIFE MANAGEMENT AREA

General. All of our field observations since the start of the Stillwater project have indicated that waterfowl make little use of the west portion of the Stillwater marsh except for a few of the shallow, marginal ponds. The reasons for this lack of utilization are apparent. The ponds are comparatively deep and turbid, they lack aquatic growth, and are surrounded by wide zones of dense cattail. Since they produce no food and possess an undesirable type of cover, they are not used by waterfowl to any extent at any season of the year.

Because much of the west portion of the marsh is of little value to waterfowl we have made an attempt to determine those factors which prohibit the growth of waterfowl food plants in this area. The influence of the heavy cattail growth was obvious, but the absence of sago pondweed, so abundant elsewhere in the marsh, presented a problem. Marsh management in the future will have to be founded on an understanding of the habitat requirements of desirable waterfowl food plants. Factors limiting or prohibiting the growth of such plants will have to be controlled in order to gain habitat improvement.

Lack of aquatic growth in such marsh areas as Lead Lake, Millen Channel, Willow Lake and Swan Lake was at first thought to result from the high turbidity of these water bodies. These lakes are noticeably dark at all times of the year. They are comparatively deep, though are well within the depth tolerance of sago pondweed.

Procedure. In order to determine if turbidity was the limiting factor we have made a series of light penetration measurements, comparing our barren waters with those which are producing sago. These tests were started in July 1950 and were repeated at intervals of approximately one month with the exception of a three-months period during the winter.

Various stations were established in the marsh, and comparative readings were made with a Secchi disk. This instrument consists of a circular disk, 8 inches in diameter, which is divided into quadrats painted alternately black and white. The disk is lowered into the water until it disappears from sight. This depth is then recorded.

The readings obtained are comparative only and are used as an indication of light penetration. They are not a measure of turbidity since such a measure is based on the quantity of suspended matter in the water.

Influence of Turbidity. The results of this investigation are of considerable interest. They do not provide a complete solution to the problem of sago pondweed distribution, but they do shed some light on the factors involved in water turbidity.

It became apparent that the character of the marsh soil is responsible for most of our turbidity. This soil is fine-grained silt, combined, in older parts of the marsh, with particles of organic material. Only slight water movement is required to agitate this silt after which it remains in suspension for long periods of time. We collected bottom samples at 10 of the stations, mixed them thoroughly with measured quantities of tap water, and then recorded settling time. Heavier particles in the samples settled out in stratified layers. The time required for the complete deposition of these heavy particles varied from 5 hours to 18 hours and 15 minutes. Even after this lapse of time the water did not become clear. It remained noticeably colored, the color varying from light brown to gray depending on the content of organic material, for an indefinite period of time. Six of the samples were kept under observation for 24 hours while 4 were held for 48 hours with little perceptible change in color. This coloring material seems to be largely colloidal plus more or less organic stain. A water sample from Stillwater Point Reservoir retained most of this finely suspended material for a week and was still noticeably colored at the end of two weeks.

Secchi disk readings were made in the Stillwater marsh and the Indian Lakes. Additional readings were also taken on the Canvasback Club since the overflow from the Club provides the major source of water for the western portion of our marsh.

Our most turbid water occurred in the Reservoir distribution system. This water system is still comparatively new so that a considerable proportion of the channels is still bare of vegetation. For this reason the current is continually scouring the channel banks and washing new material into suspension. The water from the Stillwater Diversion Canal, which empties into Stillwater Point Reservoir, carries a heavy load of silt picked up almost entirely within the length of the Canal. The Diagonal Drain, which empties into the Diversion Canal, is an old drain with vegetated banks and carries very little suspended matter. The Diversion Canal has a steep gradient along its entire 3 and 3/4 mile length, and its channel is still being eroded so actively that bank vegetation has never become established. The canal water picks up so much silt that a large delta is formin at the mouth of the canal. Furthermore, silt is rapidly filling the upper half of the Reservoir.

In the marsh the clearest open water is found in small ponds which are nor connected to the water distribution system by open channels. In other words, small ponds which are not influenced greatly by wave action and which receive water filtered through marsh vegetation are the clearest. The presence of sago or other pondweeds is another factor of considerable influence. Pondweeds bind the bottom soil and not only dampen wave action, but tend to retard the spread of sediment stirred by the action of feeding carp.

In open ponds and channels on the Stillwater marsh the Secchi disk disappeared at depths varying from 4.5 to 23 inches. Actually the clearest water occurred in depths too shallow to permit use of the disk.

At the Indian Lakes we obtained disk readings varying from 8.25 to 13.5 inches in those lakes along the water channel. The Indian Lakes also include several seep ponds fed by underground water which are exceptionally clear. In the deepest of these we were able to see the disk on the bottom at 32 inches.

The following factors contribute in some degree to the high turbidity of our marsh water:

1. Silt character
2. Current (in canals, particularly)
3. Turbulence (at structures)
4. Wave action in the larger ponds
5. Lack of bottom, or bank, cover
6. Carp action

In addition to the above we had anticipated the possibility of increased turbidity in the spring and fall as a result of water turn-over. A series of temperature readings indicated, however, that water turn-over does not occur. The marsh water is too shallow to permit any great difference between top and bottom temperatures. The greatest difference recorded was 3 degrees; the usual difference being one to two degrees.

None of the factors causing turbidity can be eliminated entirely, but in some cases it will be possible to take remedial action.

Current in the canals will always be a factor though it will become somewhat less significant as vegetation becomes established along the banks. In considering this factor it is our belief that channels in the marsh proper should be limited to the minimum required for proper water distribution.

A considerable quantity of silt is necessarily picked up by water pouring through a structure. This could be reduced by covering the bottoms and sides of the canals with riprap material throughout the turbulent area.

The only feasible method of retarding wave action in the larger ponds seems to consist of establishing emergent plant growth, preferably round-stem bulrush, in belts to serve as wave-breaks.
(Probably Scirpus acutus

Bank cover along the ditches will appear in due time. The various aquatics, which constitute bottom cover, are present wherever conditions are suitable. There is little likelihood that they will spread into other areas of our present marsh system without artificial manipulation of environmental factors.

Carp action will be subject to periodic control in those parts of the marsh where our management will permit dewatering. These fish will be difficult to eliminate, however, as we are subject to continual reinvasion through the irrigation system.

The problem of explaining the presence or absence of sago pondweed still remains. Turbidity probably has a limiting effect on sago growth in the deepest ponds, but it is not the decisive factor prohibiting such growth.

In general, sago pondweed is found in the newer parts of the marsh, i.e., the Stillwater Point Reservoir drainage which has been in existance only since 1945. Sago also occurs in some other areas, usually in water less than 2 feet deep. It is absent from most of the older parts of the marsh, regardless of water depth. It does occur in fringe ponds adjacent to the older marsh areas, but these fringe ponds become dry periodically so that they are not old in an ecological sense.

Sago grows in Stillwater Point Reservoir in water which exceeds 4 feet in depth. The Reservoir lacks any extensive emergent growth so it is subject to pronounced wave action. As a result turbidity is extremely high. Secchi disk readings ranged from 6 to 9 inches in the area of sago growth indicating a measurable light penetration varying from approximately 10% to 20% of the total depth.

Lead Lake, Willow Lake, and other water bodies lying along the original course of the old Stillwater Slough, yield a meager growth of coontail but do not produce sago. Yet they are never as turbid as Stillwater Point Reservoir. Disk readings varied from 7.5 inches to a maximum of 20 inches indicating light penetration of at least 15% to 40% of total depth. Average water depth is comparable to that at our station in the Reservoir.

Adjacent to Millen's Channel, but entirely surrounded by emergent growth (cattail and roundstem bulrush), is a small pond, about 2 acres in size and 3 to 3.5 feet in depth, which has unusually clear water. It is separated from Millen's channel by marsh growth only. There was a medium growth of bladderwort in the pond but no other aquatic plants. Light penetration, as measured by the Secchi disk, varied from 40% to 100%, the bottom being visible to the eye on one occasion. Turbidity is definitely not a deterrent to aquatic growth in this pond.

<u>Influence of Soil</u>. It seems evident that some environmental factor other than turbidity is responsible for inhibiting sago growth in the older marsh areas.

When it became apparent that the presence of sago was dependent upon factors not related to turbidity we made a field examination of the bottom soil at each station. We found that sago was usually present on those soils having the highest mineral content. The Reservoir

and Foxtail Lake , being new water bodies, have silt bottoms and produce sago in spite of high turbidity. The old marsh ponds and channels, on the other hand, have muck bottoms which are unproductive.
(? does this mean more organic material?

This distinction held, as a rule, but there were several exceptions indicating that still other factors might be involved. Several ponds with muck bottoms do support sago. These ponds are, in a sense, marginal in that they become dry for short periods during short water years. Such periods of dryness, however, have not been of sufficient duration to have resulted in any extensive loss of organic matter through oxidation.

Conclusions. Further investigation of the requirements of sago pondweed needs to be undertaken. It appears, though, that such investigations might become too involved and time consuming to be carried out with refuge personnel. We are inclined to believe that the problem could best be handled by a plant physiologist.

We have concluded tentatively that sago growth might be promoted as a result of periodic dewatering. It would appear also that periods of dessication might have to be relatively frequent, and, in the older parts of the marsh, of rather extensive duration.

Turbidity study; found small ponds were the clearest;
6 factors contributing to turbidity
Soils study;